Announcements

- Homework for tomorrow…

  Ch. 31: CQ 6, Probs. 10, 16, & 42

  CQ11: $R_b < R_c < R_a = R_e < R_d$

  30.28: a) $R = 1.5\ \Omega$ b) $R = 3.5\ \Omega$

  30.34: $I = 1.6$ A

  30.58: See solution manual

- Office hours…

  MW 10-11 am

  TR 9-10 am

  F 12-1 pm

- Tutorial Learning Center (TLC) hours:

  MTWR 8-6 pm

  F 8-11 am, 2-5 pm

  Su 1-5 pm

Chapter 31

Fundamentals of Circuits

(*Series Resistors & Real Batteries*)

Review...

Power supplied by a battery...

$$\boxed{P_{bat} = I\mathcal{E}}$$

Power dissipated by a resistor...

$$\boxed{P_R = I\Delta V_R = I^2 R = \frac{(\Delta V_R)^2}{R}}$$

i.e. 31.4: The Power of Sound

Most loudspeakers are designed to have a resistance of 8Ω.

If an 8Ω loudspeaker is connected to a stereo amplifier with a rating of 100W, what is the maximum possible current to the loudspeaker?

$$P_R = I^2 R$$

$$100W = I^2 R$$

$$I = \sqrt{\frac{100W}{R}}$$

$$I = \sqrt{12.5}$$

$$I = 3.5A$$

Kilowatt Hours

The energy dissipated by a resistor during time interval Δt is

$$E_{th} = P_R \Delta t$$

1 kW•h is equivalent to how many J's?

3.6×10^6 J

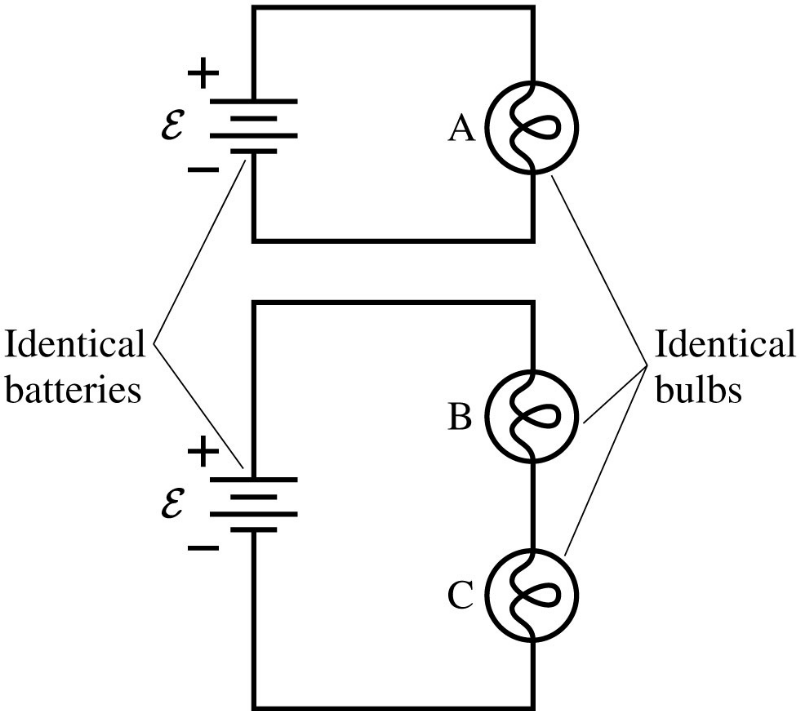
How long does it take for a 14 W c.f.l. to 'consume' this much energy?

$$\Delta t = \frac{E_{th}}{P_R} = \frac{3.6\times10^6 \text{ J}}{14 \text{ J/s}} = 2.6\times10^6 \text{ s} \times \frac{1 \text{ hr}}{3600 \text{ s}}$$

$$= 71 \text{ hr}$$

Quiz Question 1

How does the brightness of bulb *B* compare to that of bulb *A*?

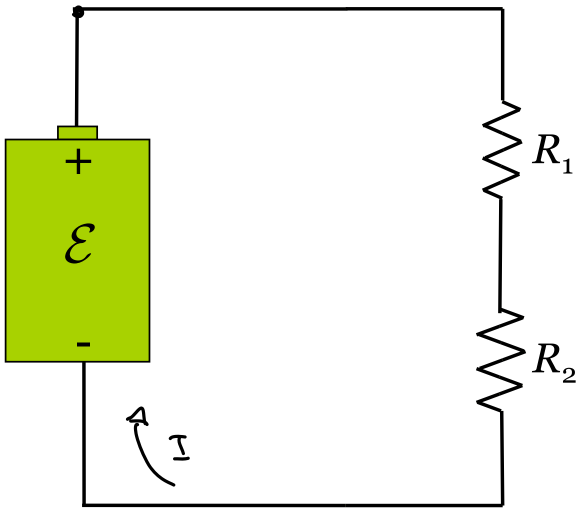


1. Bulb *B* is brighter.
2. Bulb *A* is brighter.
3. Both bulbs have the same brightness.

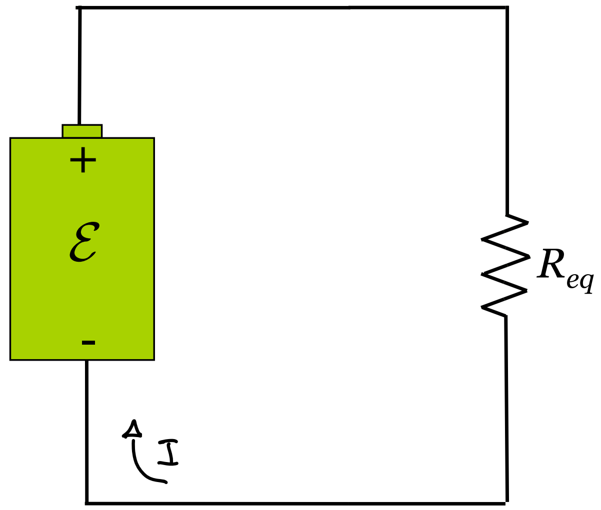
31.4:
Series Resistors

Consider two resistors in *series*…

- Can we find an *equivalent resistor*, R_{eq}, to the two resistors, R_1 & R_2?



$\stackrel{?}{=}$



$$\mathcal{E} - IR_1 - IR_2 = 0$$

$$\mathcal{E} - I(R_1 + R_2) = 0$$

$$I = \frac{\mathcal{E}}{R_1 + R_2}$$

$$\mathcal{E} - IR_{eq} = 0$$

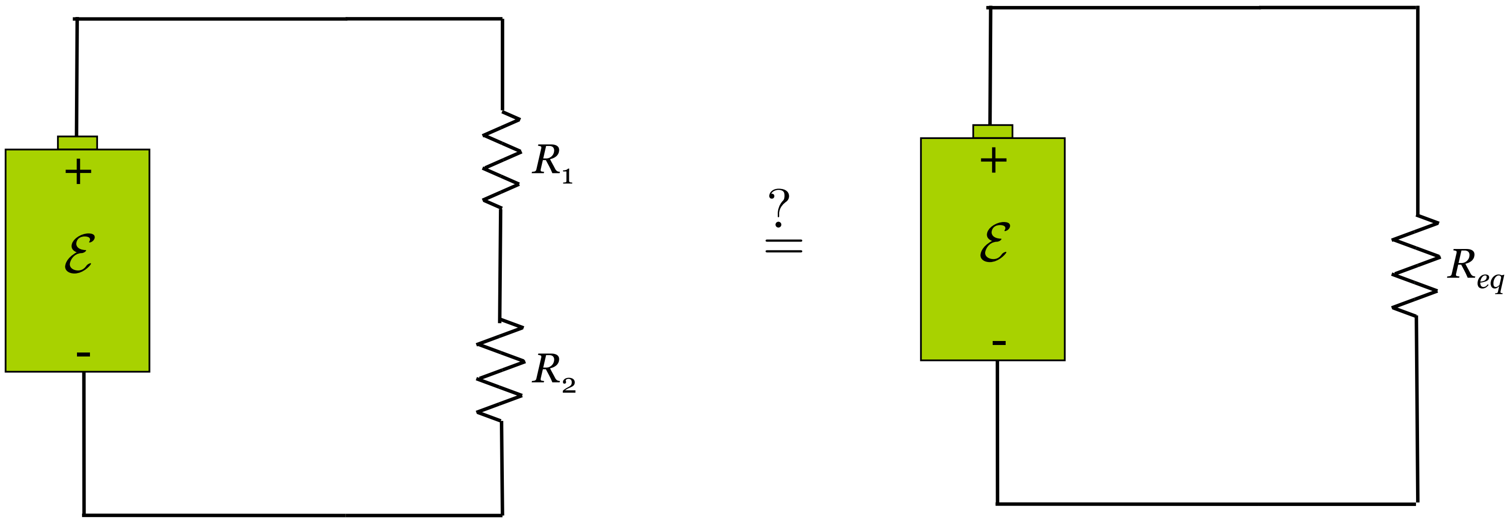
$$I = \frac{\mathcal{E}}{R_{eq}}$$

$$R_{eq} = R_1 + R_2$$

31.4:
Series Resistors

Consider two resistors in *series*…

- Can we find an *equivalent resistor*, R_{eq}, to the two resistors, R_1 & R_2?



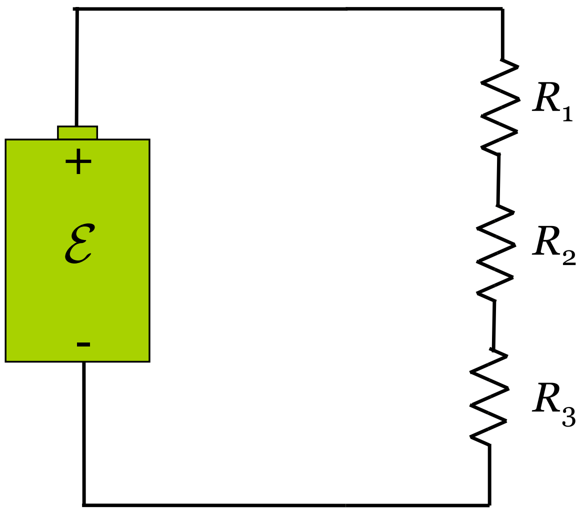
- YES!

$$R_{eq} = R_1 + R_2$$

31.4:
Series Resistors

What about several resistors in *series*…

- Can we find an *equivalent resistor*, R_{eq}, to the resistors, R_1, R_2,…*(all in series)*?



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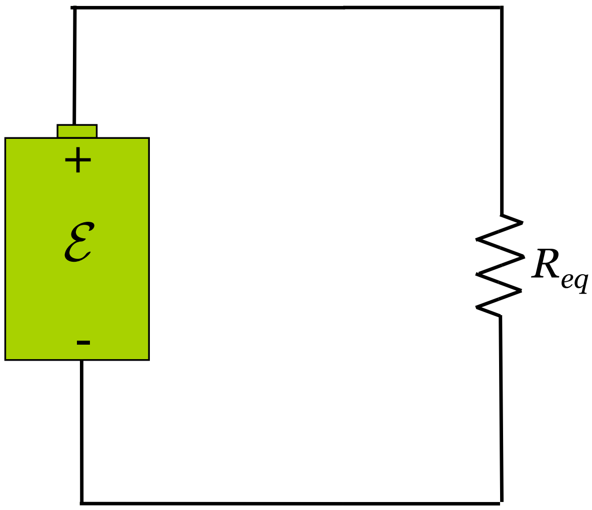
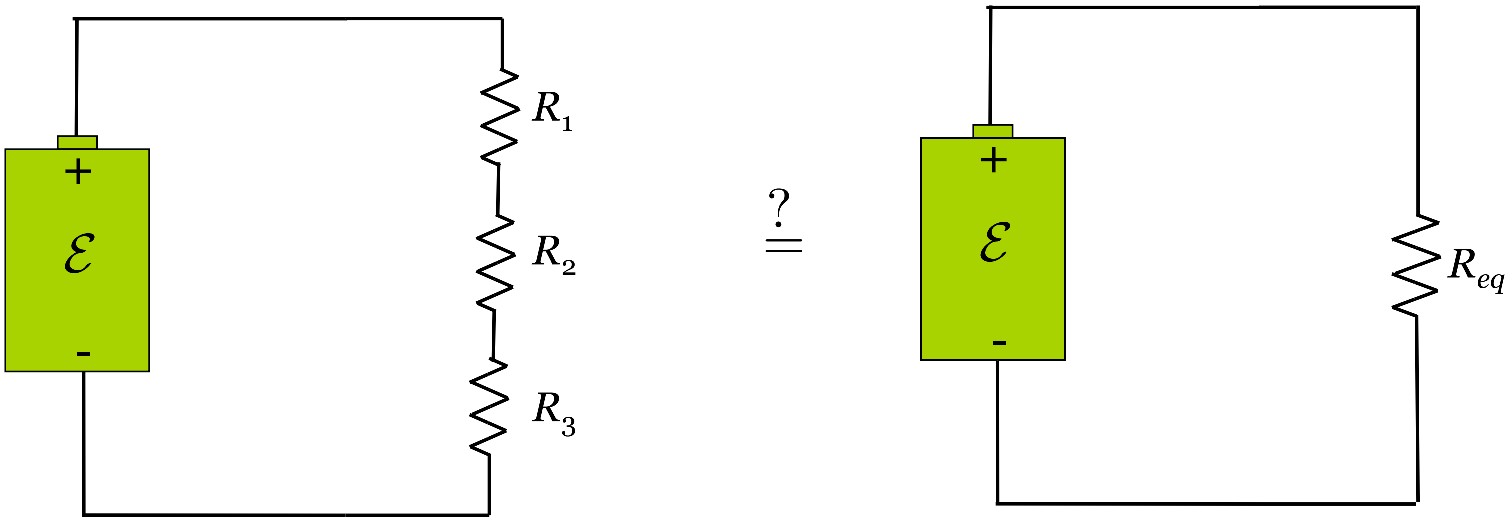


31.4:
Series Resistors

What about several resistors in *series*…

- Can we find an *equivalent resistor*, R_{eq}, to the resistors, R_1, R_2,…(*all in series*)?



- YES!

$$R_{eq} = R_1 + R_2 + \ldots$$

i.e. 31.5:
A series resistor circuit

a. What is the current in the circuit below?

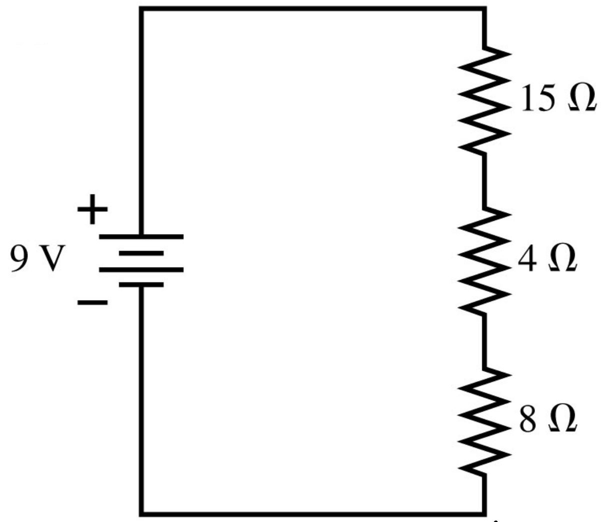
b. Draw a graph of potential versus position in the circuit, going cw from V = 0V at the battery's negative terminal.

$R = 27\,\Omega$

$\Delta V = IR$

$9V = I(27\Omega)$

$I = 0.33A$



$\Delta V_1 = I_1 R_1$

$= (\frac{1}{3}A)(15\Omega)$

$\Delta V_1 = 5V$

$\Delta V_2 = I R_2$

$= (\frac{1}{3}A)(4\Omega)$

$\Delta V_2 = \frac{4}{3}V$

$\Delta V_3 = I R_3$

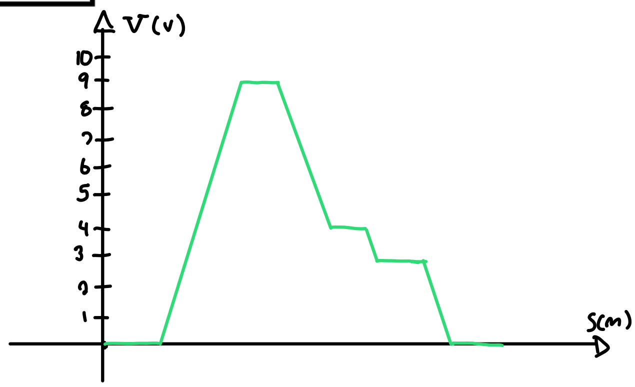
$= (\frac{1}{3}A)(8\Omega)$

$\Delta V_3 = \frac{8}{3}V$

$\Delta V_1 = 5V$

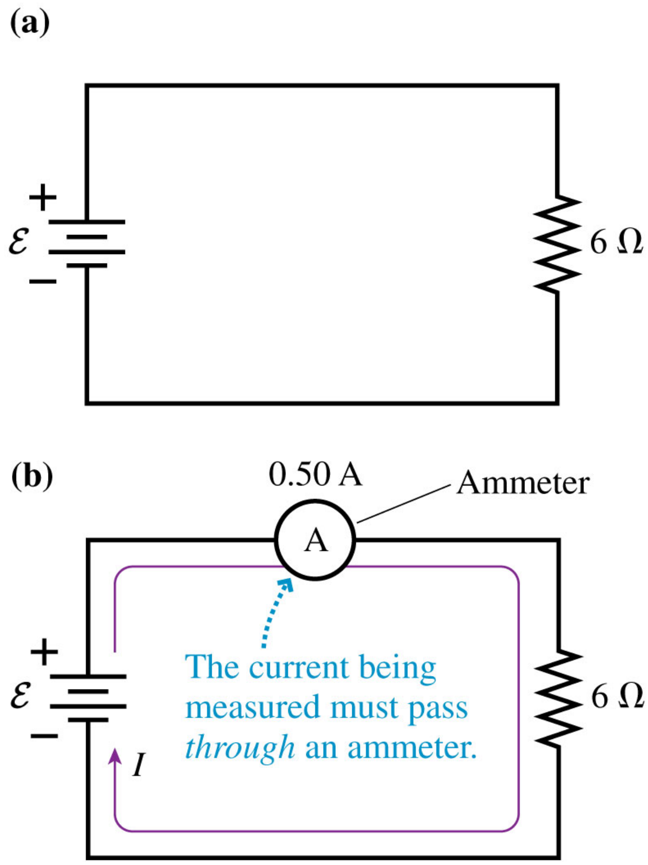
$\Delta V_2 = \frac{4}{3}V$

$\Delta V_3 = \frac{8}{3}V$



Ammeters…

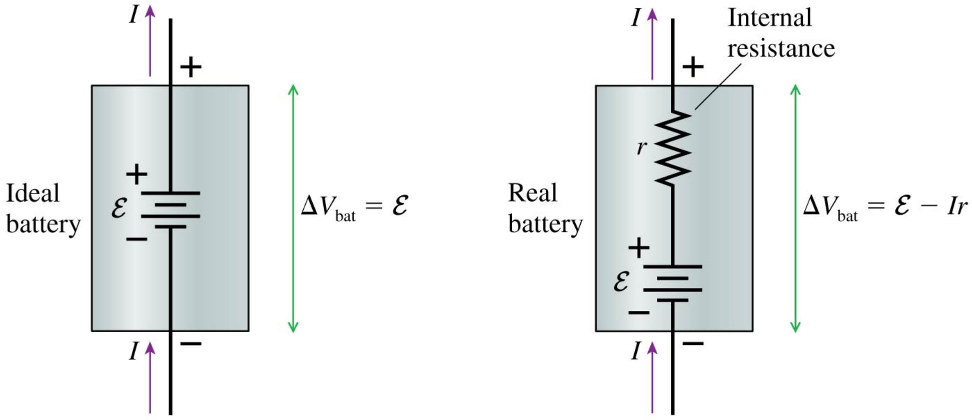
- are used to measure *currents*.
- must be wired in *series* with the circuit element whose current is to be measured.
- have $R_{ammeter}$~0 Ω



31.5: Real Batteries

- have an *internal resistance, r*
- The *terminal voltage* is...

$$\Delta V_{bat} = \mathcal{E} - Ir \leq \mathcal{E}$$

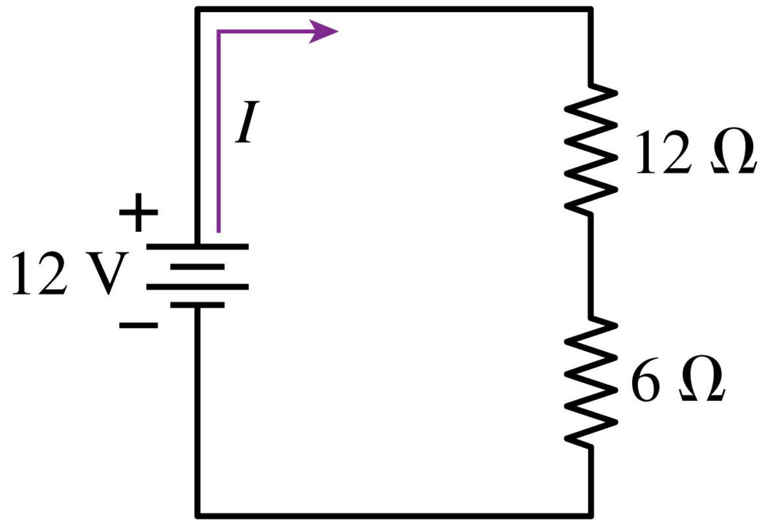


Notice:

- *only* when I = 0 is $\Delta V_{bat} = \mathcal{E}$.

Quiz Question 2

The battery current I is



1. 3 A.
2. 1.5 A.
3. 1 A.
4. 2/3 A.
5. 1/3 A.

$12V - I(12\Omega) - I(6\Omega) = 0$

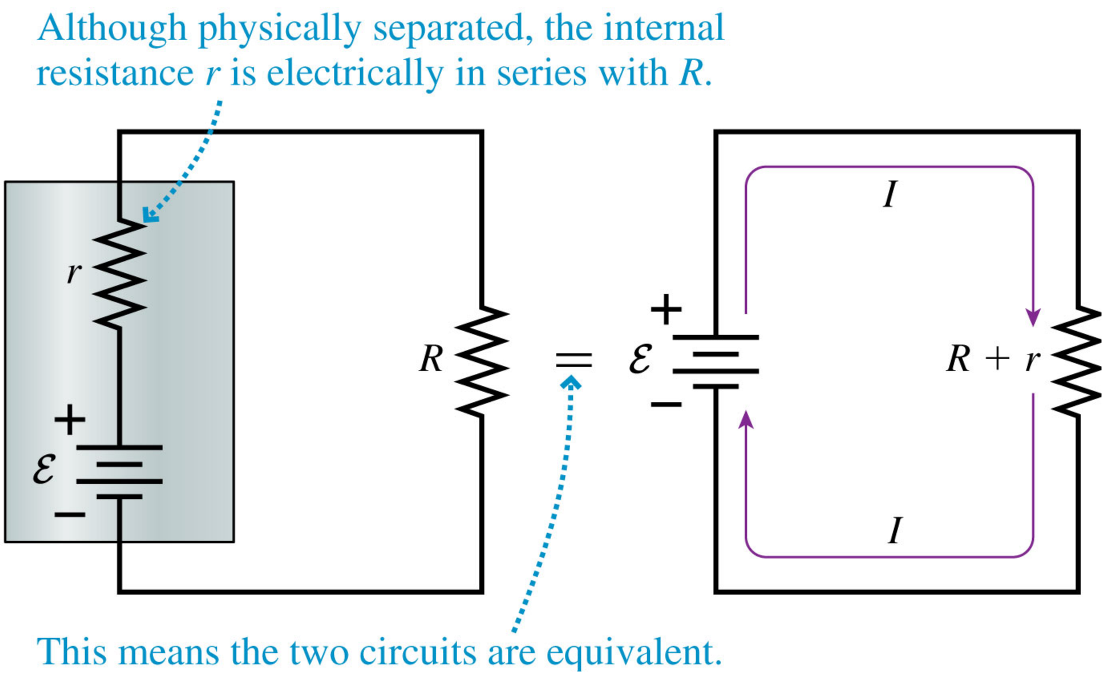
$I(18\Omega) = 12V$

$I = \frac{2}{3}A$

Quiz Question 3

A *real* battery has an *emf*, $\mathcal{E}$, and a *terminal voltage*, ΔV_{bat}, where $\Delta V_{bat} < \mathcal{E}$.

The voltage drop across the resistor R is equal to



1. $\mathcal{E}$.
2. ΔV_{bat}.
3. both.
4. neither.